DOCUMENT RESUME

ED 216 938 SE 038 142

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TITLE The Rise and Fall of the Bering Land Bridge. Crustal Evolution Education Project. Teacher's Guide [and] Student Investigation.
INSTITUTION National Association of Geology Teachers.
SPONS AGENCY National Science Foundation, Washington, D.C.
REPORT NO CEEP-MOD-TX20-1-8; ISBN-0-89873-052-X; ISBN-0-89873-053-8
PUB DATE 79
GRANT SED-75-20151; SED-77-08539; SED-78-25104
NOTE 23p.
AVAILABLE FROM Ward's Natural Science Establishment, Inc., P.O. Box 1712, Rochester, NY 14603 (or P.O. Box 1749, Monterey, CA 93940.)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Earth Science; Geographic Location; *Geology; Instructional Materials; Oceanography; Paleontology; *Science Activities; *Science Course Improvement Projects; Science Curriculum; Science Education; Science Instruction; Secondary Education; *Secondary School Science; *Seismology; Teaching Guides; Teaching Methods
IDENTIFIERS *Crustal Evolution Education Project; National Science Foundation; *Plate Tectonics

ABSTRACT

Crustal Evolution Education Project (CEEP) modules were designed to: (1) provide students with the methods and results of continuing investigations into the composition, history, and processes of the earth's crust and the application of this knowledge to man's activities and (2) to be used by teachers with little or no previous background in the modern theories of sea-floor spreading, continental drift, and plate tectonics. Each module consists of two booklets: a teacher's guide and student investigation. The teacher's guide contains all of the information present in the student investigation booklet as well as: (1) a general introduction; (2) prerequisite student background; (3) objectives; (4) list of required materials; (5) background information; (6) suggested approach; (7) procedure, recommending one 45-minute class period for this module; (8) summary questions (with answers); (9) extension activities; and (10) list of references. Focusing on a land bridge (connection between two land masses), students explain how the Bering Land Bridge first became possible, list two animals that migrated during each of the two major time periods, and explain two ways for a land bridge to become exposed or submerged. (Author/JN)

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CRUSTAL EVOLUTION EDUCATION PROJECT

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The Rise And Fall Of The Bering Land Bridge

TEACHER'S GUIDE

Catalog No. 34W1027

For use with Student Investigation 34W1127
Class time: two 45-minute periods

Developed by
THE NATIONAL ASSOCIATION OF GEOLOGY TEACHERS

Produced and Distributed by
Ward's Natural Science Establishment, Inc. Rochester, NY • Monterey, CA

SE 038 142

NAGT Crustal Evolution Education Project

Edward C. Stoever, Jr., Project Director

Welcome to the exciting world of current research into the composition, history and processes of the earth's crust and the application of this knowledge to man's activities. The earth sciences are currently experiencing a dramatic revolution in our understanding of the way in which the earth works. CEEP modules are designed to bring into the classroom the methods and results of these continuing investigations. The Crustal Evolution Education Project began work in 1974 under the auspices of the National Association of Geology Teachers. CEEP materials have been developed by teams of science educators, classroom teachers, and scientists. Prior to publication, the materials were field tested by more than 200 teachers and over 12,000 students.

Current crustal evolution research is a breaking story that students are living through today. Teachers and students alike have a unique opportunity through CEEP modules to share in the unfolding of these educationally important and exciting advances. CEEP modules are designed to provide students with appealing firsthand investigative experiences with concepts which are at or close to the frontiers of scientific inquiry into plate tectonics. Furthermore, the CEEP modules are designed to be used by teachers with little or no previous background in the modern theories of sea-floor spreading, continental drift and plate tectonics.

We know that you will enjoy using CEEP modules in your classroom. Read on, and be prepared to experience a renewed enthusiasm for teaching as you learn more about the living earth in this and other CEEP modules.

About CEEP Modules...

Most CEEP modules consist of two booklets: a Teacher's Guide and a Student Investigation. The Teacher's Guide contains all the information and illustrations in the Student Investigation, plus sections printed in color, intended only for the teacher, as well as answers to the questions that are included in the Student Investigation. In some modules, there are illustrations that appear only in the Teacher's Guide, and these are designated by figure letters instead of the number sequence used in the Student Investigation.

For some modules, maps, rulers and other common classroom materials are needed, and in varying quantities according to the method of presentation. Read over the module before scheduling its use in class and refer to the list of MATERIALS in the module.

Each module is individual and self-contained in content, but some are divided into two or more parts for convenience. The recommended length of time for each module is indicated. Some modules require prerequisite knowledge of some aspects of basic earth science; this is noted in the Teacher's Guide.

The material was prepared with the support of National Science Foundation Grant Nos. SED 75-20151, SED 77-08539, and SED 78-25104. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of NSF.

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The Rise And Fall Of The Bering Land Bridge

INTRODUCTION

A **land bridge** is a connection between two landmasses. Certain circumstances may make the bridge disappear. The two landmasses are then separated by water. During the time when water lies between the masses, it is difficult for animals to cross. When the land bridge is present, it is relatively easy for animals to cross.

The Bering Strait separates North America from Asia. It is a short distance. A submerged land bridge now exists where there has been dry land at various times in the past. Scientists believe this to have been one of the most important routes for animal migration between North America and Asia.

The distance between the landmasses has not always been short. The drifting of the North American Plate eventually brought the two masses close enough for a bridge to be possible. Before that time, no connection at this location was possible, because the continental masses were separated by a wide, deep ocean.

PREREQUISITE STUDENT BACKGROUND

Basic knowledge of continental drift would be helpful. Specifically, students should realize that after the breakup of Pangaea, the North American Plate moved in a generally northwesterly direction.

A concept of animal distribution around the world would also be useful. Students should realize that animals were not always widely distributed around the planet. The present location of the Bering Strait should be pointed out to the students. Explain what a land bridge is and how it may form. Also explain how the fossil record could show the opening and closing of the land bridge.

OBJECTIVES

After you have completed these activities, you should be able to:

1. Explain how the Bering Land Bridge first became possible.
2. List two animals that migrated during each of two major time periods.
3. Explain two ways for a land bridge to become exposed or submerged.

MATERIALS

Scissors
Tape (or glue)
Colored pencils or pens

BACKGROUND INFORMATION

The Bering Land Bridge has been one of the world's most important migration routes for about 100 million years. The northwest movement and then counterclockwise rotation of the North American Plate brought the two landmasses close together by the end of the Cretaceous.

Throughout their existence, land animals have moved about and migrated to new areas under various conditions. Three important methods of migration across the Bering Strait are:

a. Direct migration across relatively dry land.

b. Filter bridge. Due to environmental stresses (in the case of the Bering area, extreme cold) some animals pass while others cannot.

c. "Sweepstakes" route. If areas are separated by an obstacle, such as water in the Bering Strait, migration may take place in a lucky way, such as floating across on a log or an iceberg.

This activity has several scientific limitations. At times the existence of the bridge would depend on changes in sea level. The maps used in this activity depict present day coastlines. Ancient coastlines would have been different. Also maps on Worksheets 2 and 3 do not indicate the direction of migration since it is somewhat unclear from the fossil record.

SUGGESTED APPROACH

If tape is in short supply, students may use glue for the animal symbols. Tape should be used for the top edge of the maps and bridge symbols on the Worksheets so that they will flip up and down easier. (Please note: some students may require an extra period to complete the map.)

The procedure is in a step-by-step format so students should have little trouble producing the maps on the Worksheets if they read and follow the steps carefully. After you present any necessary background information, most students should be able to work through the activity without help. Only at one point are they instructed to show an answer to a question to you. It would be a good idea to walk around and make sure they are following instructions.

PROCEDURE

PART A: **Students produce the base map that represents a time before any migration, and then plot migration patterns for the Mesozoic Era.**

Key word: land bridge

Time required: one 45-minute period

Materials: scissors, tape (or glue) and colored pencils or pens.

Carefully separate the last three pages from this booklet. Follow the instructions step-by-step. (Note: All of the maps on the Worksheets outline the continents with their present-day coastlines. Sea level has varied greatly through geologic time so it is unlikely they looked exactly like this.)

Worksheet 1

1. After the words, Paleozoic to Mesozoic, write the following: "Continents in motion. Distance between too great for land bridge. No migration. Up to about 100 million years ago."

2. With a colored pencil, draw large arrows to indicate the motion of North America.

3. With a different colored pencil, draw a small circle around the place in North America and the place in Asia that will later be on either side of the Bering Strait.

Worksheet 2

This map covers the migration of some dinosaurs. It will be the most crowded of the maps. The lines that connect similar animals need not cross the bridge. Students should realize that fossil evidence shows each pair to be either exactly alike, or at least very similar.

1. Separate the map on Worksheet 2 from the rest of the page by cutting along the dashed line. Trim the top edge of the map along its top border.

2. Carefully tape or glue only the top edge so that it lies along the line on top of Worksheet 1.

3. After the words, Late Mesozoic, write the sentence, "Migration of dinosaurs. First connection—Late Cretaceous. 100 million years ago."

4. Cut out one of the three bridge symbols.

5. Tape the top edge of the bridge symbol over the Bering Strait so that it can flip up and down.

6. Now cut out dinosaur symbols a through l.

7. Tape or glue the dinosaur symbols on the continents as follows:

a. Duckbilled - Saurolophus - Asia
b. Duckbilled - Saurolophus - North America
c. Giant predator - Tarbosaurus - Asia
d. Giant predator - Tyrannosaurus - North America
e. Armored - Pinacosaurus - Asia
f. Armored - Ankylosaurus - North America
g. Horned - Asia
h. Horned - North America
i. Ostrich-like - ornithomimids - Asia
j. Ostrich-like - ornithomimids - North America
k. Dome-headed - Pachycephalosaurus - Asia
l. Dome-headed - Pachycephalosaurus - North America

8. Connect like animals with colored lines.

9. Look at Worksheet 2 and answer the following: How did the dinosaurs get distributed as they are?

By walking across the strait on a land bridge.

How did scientists find evidence for these dinosaurs?

By finding fossils.

PROCEDURE

PART B: **Students plot migration patterns for the Cenozoic Era.**

Key words: none

Time required: one 45-minute period

Materials: scissors, tape (or glue) and colored pencils or pens.

Worksheet 3

On this map of early mammal migration students may want to draw their connecting lines over the land bridge.

Make sure students understand the answers to the questions. Sea level changes in recent times have been due to ice ages and remelting. An ice age may lower the sea level as much as 100 meters.

1. Separate Worksheet 3 from Worksheet 4 by cutting along the dashed line. Trim off the border at the top edge of each map.

2. Carefully tape only the top edge of Worksheet 3 over the same line on which you taped Worksheet 2.

3. After the words, Early Tertiary, write: "Early mammal migration. 65 million years ago."

4. Cut out animal symbols m through r.

5. Cut out one of the bridge symbols.

6. Tape the top edge of the bridge symbol over the Bering Strait so that it matches and can be flipped up.

7. Tape or glue the animals on the continents as follows:

m. Primitive mammals - multituberculates - Asia
n. Primitive mammals - multituberculates - North America
o. Ancestor of shrews - insectivores - Asia
p. Ancestor of shrews - insectivores - North America
q. Early hoofed mammals - ungulates - Asia
r. Early hoofed mammals - ungulates - North America

8. Connect like animals with colored lines. The bridge was only usable from time to time during this period. (That is why you can flip the bridge!) There are two ways for the bridge to become usable. See if you can guess what they are.

The sea level may drop enough for the land between to become dry. The crust of the earth under the bridge may be uplifted higher than sea level.

Check with your teacher before continuing.

Worksheet 4

The map on Worksheet 4 shows recent migration. The direction of migration is documented so students only have one symbol for each animal and will draw a long arrow instead of a connecting line.

1. Tape the top edge of Worksheet 4 along the same line as before.

2. Cut out the remaining map symbols. After the words, Mid-Tertiary to Present, write, "Recent migration. 35 million years ago to modern day."

3. Cut out and tape the top edge of the remaining bridge symbol over the Bering Strait as before.

4. Tape or glue the remaining animals on the continents as follows:

s. Horses - North America
t. Camels - North America
u. Bison - Asia
v. Elephants - Asia
w. Pigs - Asia
x. Humans - Asia

5. With colored pencils draw long arrows from s and t, making the heads of the arrows in Asia.

6. Draw long arrows from u and v so the heads of the arrows are in North America.

7. Under Pig write, "No migration through strait," which means that the pigs did not migrate through the Bering Strait.

8. Draw an arrow from the human in Asia across the Bering Strait with the head of the arrow in North America.

9. Below this line write the words, "about 15,000 years ago". Scientists are more certain of the origin and migration patterns of the animals on this map, than of the kinds shown on your other maps.

Now you have a finished map of the migration of animals across the Bering Land Bridge after continental drift brought the continents close together.

SUMMARY QUESTIONS

1. What prevented the Bering Land Bridge from being used before the Cretaceous?
There was a deep ocean between them. The plates had not drifted close enough.

2. List two dinosaurs (common or scientific names) that migrated during the Cretaceous.
Duckbilled (Saurolophus), giant predator (Tarbosaurus—Tyrannosaurus), armored (Pinacosaurus—Ankylosaurus), horned, ostrich-like (ornithomimids), dome-headed (Pachycephalosaurus).

3. List two early mammals that migrated.
Primitive mammals (multituberculates), ancestor of shrews (insectivores), early hoofed mammals (ungulates).

4. List two recent animals that migrated.
Horses, camels, bison, elephants, humans.

5. Why did you construct the bridge to flip up?
Because the bridge can only be used from time to time.

6. Explain how a land bridge can disappear.
The sea level rises or the crust of the earth under the bridge subsides.

EXTENSION

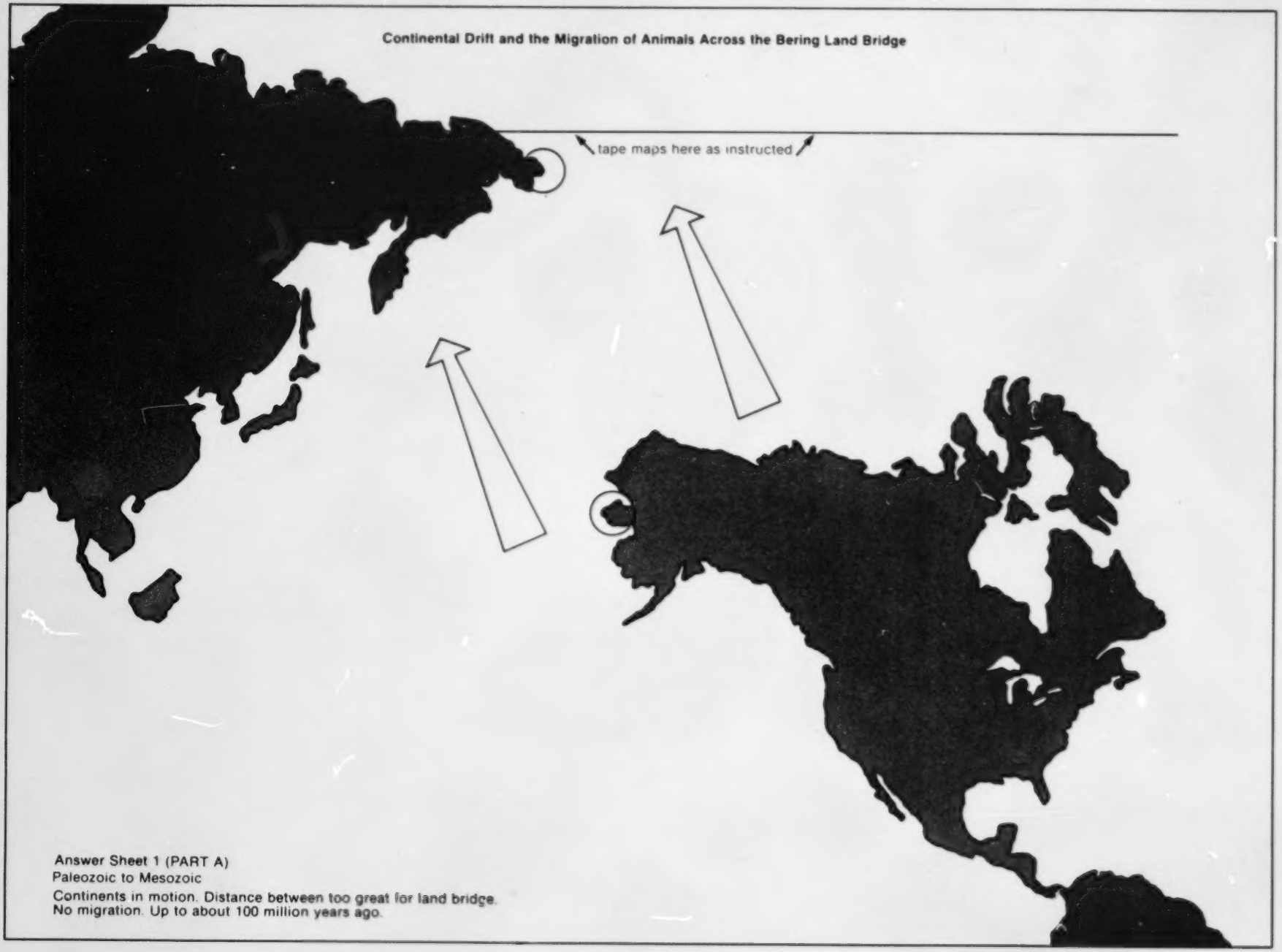
If you want your map to be complete, write out an appropriate key to the animal symbols on the map and tape it along the same line on which you taped Worksheets 2, 3 and 4 on 1.

REFERENCE

Colbert, E.H., 1976, Fossils and the drifting continents. *Fossils Magazine*, v. 1, no. 1, p. 5-22.

Continental Drift and the Migration of Animals Across the Bering Land Bridge

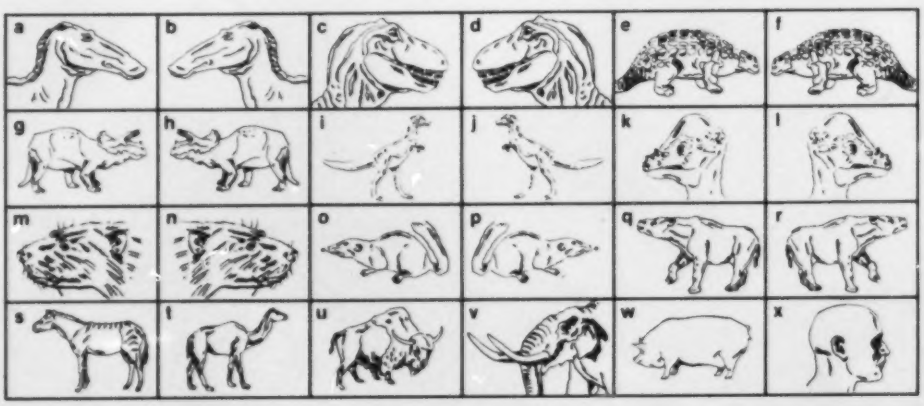
tape maps here as instructed



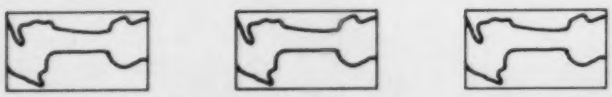
Answer Sheet 1 (PART A)
Paleozoic to Mesozoic
Continents in motion. Distance between too great for land bridge.
No migration. Up to about 100 million years ago.

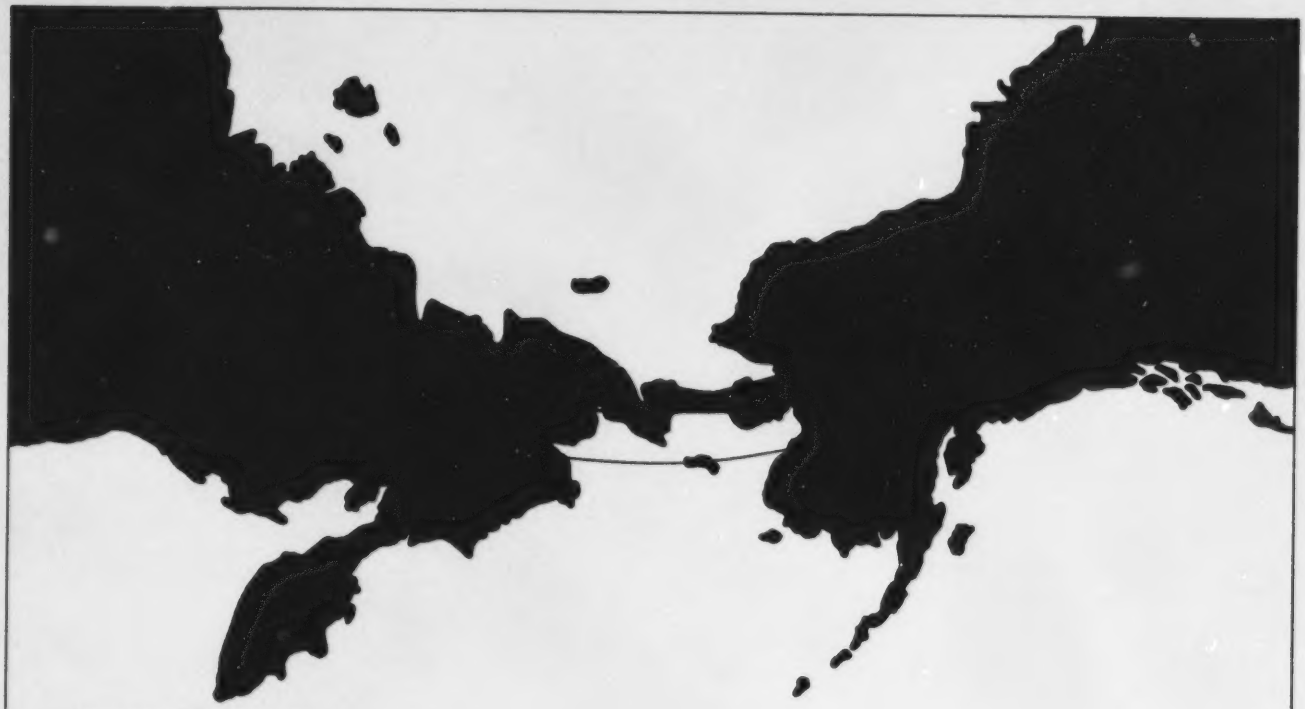
Answer Sheet 2 (PART A)
Late Mesozoic
Migration of dinosaurs. First connection—Late Cretaceous. 100 million years ago.

Animal and Map Symbols

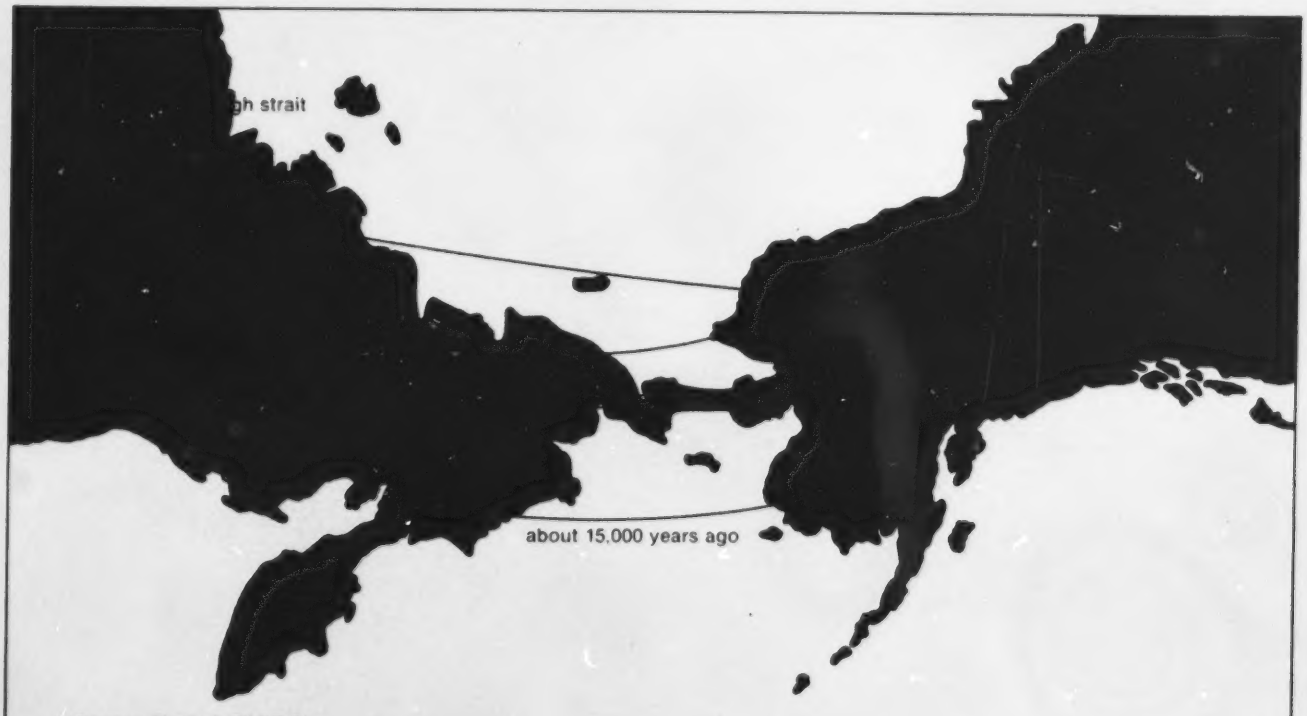


Bridges





Answer Sheet 3 (PART B)
Early Tertiary
Early mammal migration. 65 million years ago.



Answer Sheet 4 (PART B)
Mid-Tertiary to Present
Recent migration. 35 million years ago to modern day.

NAGT Crustal Evolution Education Project Modules

CEEP Modules are listed here in alphabetical order. Each Module is designed for use in the number of class periods indicated. For suggested sequences of CEEP Modules to cover specific topics and for correlation of CEEP Modules to standard earth science textbooks, consult Ward's descriptive literature on CEEP. The Catalog Numbers shown here refer to the CLASS PACK of each Module consisting of a Teacher's Guide and 30 copies of the Student Investigation. See Ward's descriptive literature for alternate order quantities.

CEEP Module	Class Periods	CLASS PACK Catalog No.
• A Sea-floor Mystery: Mapping Polarity Reversals	3	34 W 1201
• Continents And Ocean Basins: Floaters And Sinkers	3-5	34 W 1202
• Crustal Movement: A Major Force In Evolution	2-3	34 W 1203
• Deep Sea Trenches And Radioactive Waste	1	34 W 1204
• Drifting Continents And Magnetic Fields	3	34 W 1205
• Drifting Continents And Wandering Poles	4	34 W 1206
• Earthquakes And Plate Boundaries	2	34 W 1207
• Fossils As Clues To Ancient Continents	2-3	34 W 1208
• Hot Spots In The Earth's Crust	3	34 W 1209
• How Do Continents Split Apart?	2	34 W 1210
• How Do Scientists Decide Which Is The Better Theory?	2	34 W 1211
• How Does Heat Flow Vary In The Ocean Floor?	2	34 W 1212
• How Fast Is The Ocean Floor Moving?	2-3	34 W 1213
• Iceland: The Case Of The Splitting Personality	3	34 W 1214
• Imaginary Continents: A Geological Puzzle	2	34 W 1215
• Introduction To Lithospheric Plate Boundaries	1-2	34 W 1216
• Lithospheric Plates And Ocean Basin Topography	2	34 W 1217
• Locating Active Plate Boundaries By Earthquake Data	2-3	34 W 1218
• Measuring Continental Drift: The Laser Ranging Experiment	2	34 W 1219
• Microfossils, Sediments And Sea-floor Spreading	4	34 W 1220
• Movement Of The Pacific Ocean Floor	2	34 W 1221
• Plate Boundaries And Earthquake Predictions	2	34 W 1222
• Plotting The Shape Of The Ocean Floor	2-3	34 W 1223
• Quake Estate (board game)	3	34 W 1224
• Spreading Sea Floors And Fractured Ridges	2	34 W 1225
• The Rise And Fall Of The Bering Land Bridge	2	34 W 1227
• Tropics In Antarctica?	2	34 W 1228
• Volcanoes: Where And Why?	2	34 W 1229
• What Happens When Continents Collide?	2	34 W 1230
• When A Piece Of A Continent Breaks Off	2	34 W 1231
• Which Way Is North?	3	34 W 1232
• Why Does Sea Level Change?	2-3	34 W 1233

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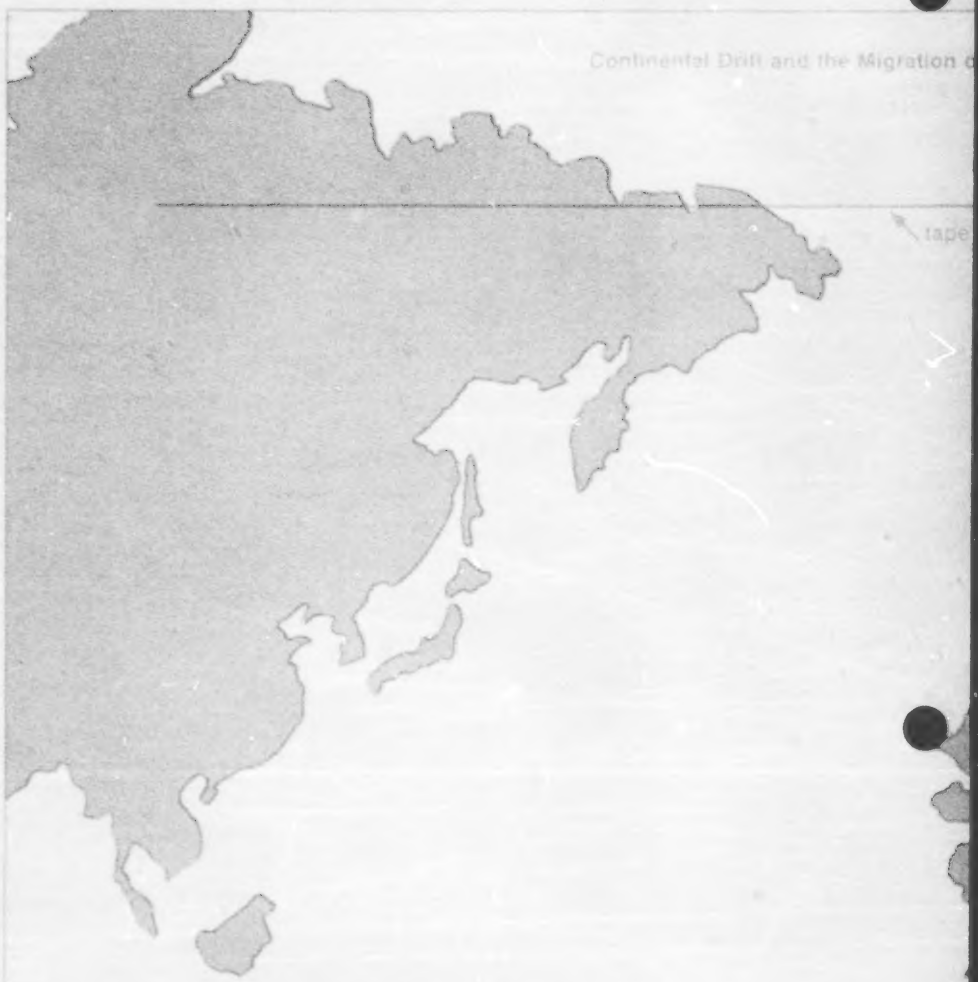

WARD'S
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CEEP MODULE NO. TX2R 1-6
ISBN: 0-89573-669-X
Printed in U.S.A.

CRUSTAL EVOLUTION EDUCATION PROJECT

NAME DATE

Student Investigation

Catalog No. 34W1127

The Rise And Fall Of The Bering Land Bridge

INTRODUCTION

A **land bridge** is a connection between two landmasses. Certain circumstances may make the bridge disappear. The two landmasses are then separated by water. During the time when water lies between the masses, it is difficult for animals to cross. When the land bridge is present, it is relatively easy for animals to cross.

The Bering Strait separates North America from Asia. It is a short distance. A submerged land bridge now exists where there has been dry land at various times in the past. Scientists believe this to have been one of the most important routes for animal migration between North America and Asia.

The distance between the landmasses has not always been short. The drifting of the North American Plate eventually brought the two masses close enough for a bridge to be possible. Before that time, no connection at this location was possible, because the continental masses were separated by a wide, deep ocean.

OBJECTIVES

After you have completed these activities, you should be able to:

1. Explain how the Bering Land Bridge first became possible.
2. List two animals that migrated during each of two major time periods.
3. Explain two ways for a land bridge to become exposed or submerged.

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PROCEDURE

PART A

Materials: scissors, tape (or glue) and colored pencils or pens.

Carefully separate the last three pages from this booklet. Follow the instructions step-by-step. (Note: All of the maps on the Worksheets outline the continents with their present-day coastlines. Sea level has varied greatly through geologic time so it is unlikely they looked exactly like this.)

Worksheet 1

1. After the words, Paleozoic to Mesozoic, write the following: "Continents in motion. Distance between too great for land bridge. No migration. Up to about 100 million years ago."

2. With a colored pencil, draw large arrows to indicate the motion of North America.

3. With a different colored pencil, draw a small circle around the place in North America and the place in Asia that will later be on either side of the Bering Strait.

Worksheet 2

1. Separate the map on Worksheet 2 from the rest of the page by cutting along the dashed line. Trim the top edge of the map along its top border.

2. Carefully tape or glue only the top edge so that it lies along the line on top of Worksheet 1.

3. After the words, Late Mesozoic, write the sentence, "Migration of dinosaurs. First connection—Late Cretaceous. 100 million years ago."

4. Cut out one of the three bridge symbols.

5. Tape the top edge of the bridge symbol over the Bering Strait so that it can flip up and down.

6. Now cut out dinosaur symbols a through l.

7. Tape or glue the dinosaur symbols on the continents as follows:

a. Duckbilled - Saurolophus - Asia
b. Duckbilled - Saurolophus - North America
c. Giant predator - Tarbosaurus - Asia
d. Giant predator - Tyrannosaurus - North America
e. Armored - Pinacosaurus - Asia
f. Armored - Ankylosaurus - North America
g. Horned - Asia
h. Horned - North America
i. Ostrich-like - ornithomimids - Asia
j. Ostrich-like - ornithomimids - North America
k. Dome-headed - Pachycephalosaurus - Asia
l. Dome-headed - Pachycephalosaurus - North America

8. Connect like animals with colored lines.

9. Look at Worksheet 2 and answer the following: How did the dinosaurs get distributed as they are?

How did scientists find evidence for these dinosaurs?

PROCEDURE

PART B

Materials: scissors, tape (or glue) and colored pencils or pens.

Worksheet 3

1. Separate Worksheet 3 from Worksheet 4 by cutting along the dashed line. Trim off the border at the top edge of each map.

2. Carefully tape only the top edge of Worksheet 3 over the same line on which you taped Worksheet 2.

3. After the words, Early Tertiary, write: "Early mammal migration. 65 million years ago."

4. Cut out animal symbols m through r.

5. Cut out one of the bridge symbols.

6. Tape the top edge of the bridge symbol over the Bering Strait so that it matches and can be flipped up.

7. Tape or glue the animals on the continents as follows:

m. Primitive mammals - multituberculates - Asia
n. Primitive mammals - multituberculates - North America
o. Ancestor of shrews - insectivores - Asia
p. Ancestor of shrews - insectivores - North America
q. Early hoofed mammals - ungulates - Asia
r. Early hoofed mammals - ungulates - North America

8. Connect like animals with colored lines. The bridge was only usable from time to time during this period. (That is why you can flip the bridge!) There are two ways for the bridge to become usable. See if you can guess what they are.

Check with your teacher before continuing.

Worksheet 4

1. Tape the top edge of Worksheet 4 along the same line as before.

2. Cut out the remaining map symbols. After the words, Mid-Tertiary to Present, write, "Recent migration. 35 million years ago to modern day."

3. Cut out and tape the top edge of the remaining bridge symbol over the Bering Strait as before.

4. Tape or glue the remaining animals on the continents as follows:

s. Horses - North America
t. Camels - North America
u. Bison - Asia
v. Elephants - Asia
w. Pigs - Asia
x. Humans - Asia

5. With colored pencils draw long arrows from s and t, making the heads of the arrows in Asia.

6. Draw long arrows from u and v so the heads of the arrows are in North America.

7. Under Pig write, "No migration through strait," which means that the pigs did not migrate through the Bering Strait.

8. Draw an arrow from the human in Asia across the Bering Strait with the head of the arrow in North America.

9. Below this line write the words, "about 15,000 years ago". Scientists are more certain of the origin and migration patterns of the animals on this map, than of the kinds shown on your other maps.

Now you have a finished map of the migration of animals across the Bering Land Bridge after continental drift brought the continents close together.

SUMMARY QUESTIONS

1. What prevented the Bering Land Bridge from being used before the Cretaceous?

2. List two dinosaurs (common or scientific names) that migrated during the Cretaceous.

3. List two early mammals that migrated.

4. List two recent animals that migrated.

5. Why did you construct the bridge to flip up?

6. Explain how a land bridge can disappear.

EXTENSION

If you want your map to be complete, write out an appropriate key to the animal symbols on the map and tape it along the same line on which you taped Worksheets 2, 3 and 4 on 1.

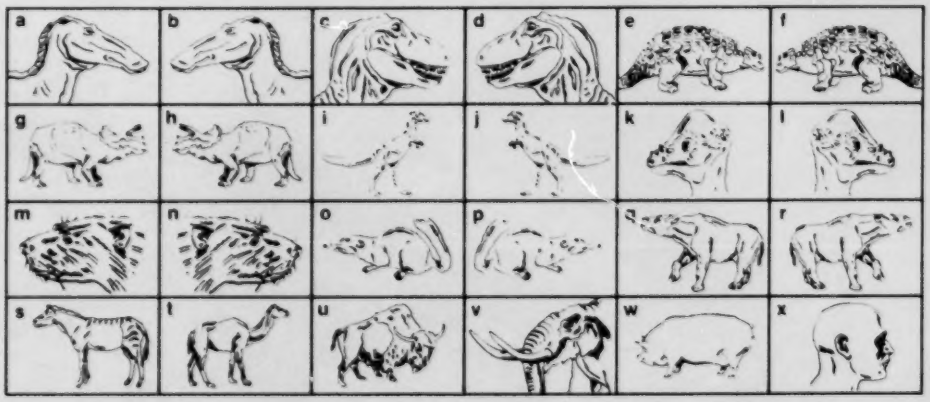
Continental Drift and the Migration of Animals Across the Bering Land Bridge

tape maps here as instructed

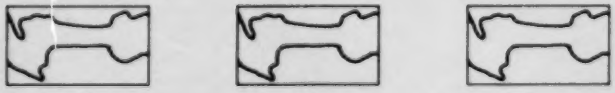
Worksheet 1 (PART A)
Paleozoic to Mesozoic

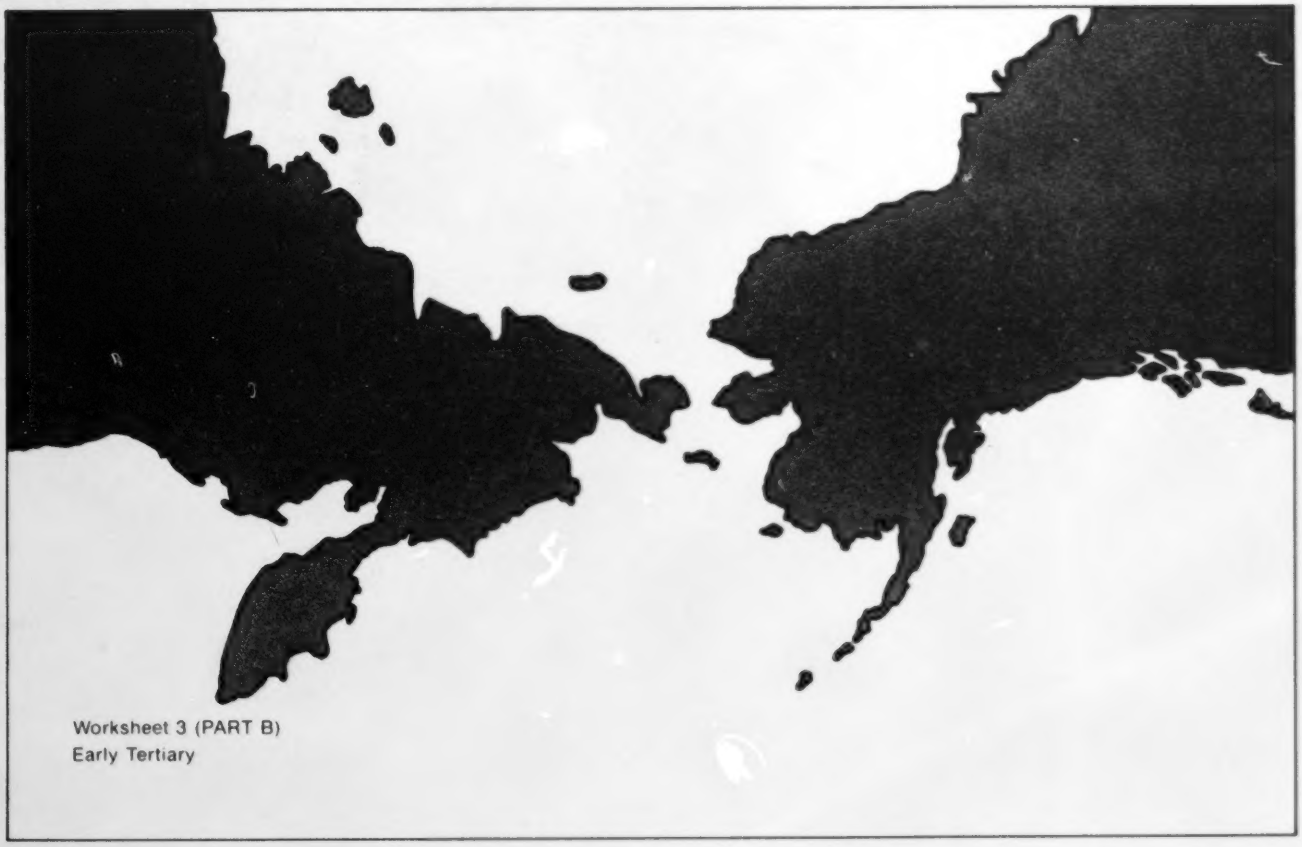
Worksheet 2 (PART A)
Late Mesozoic

Animal and Map Symbols

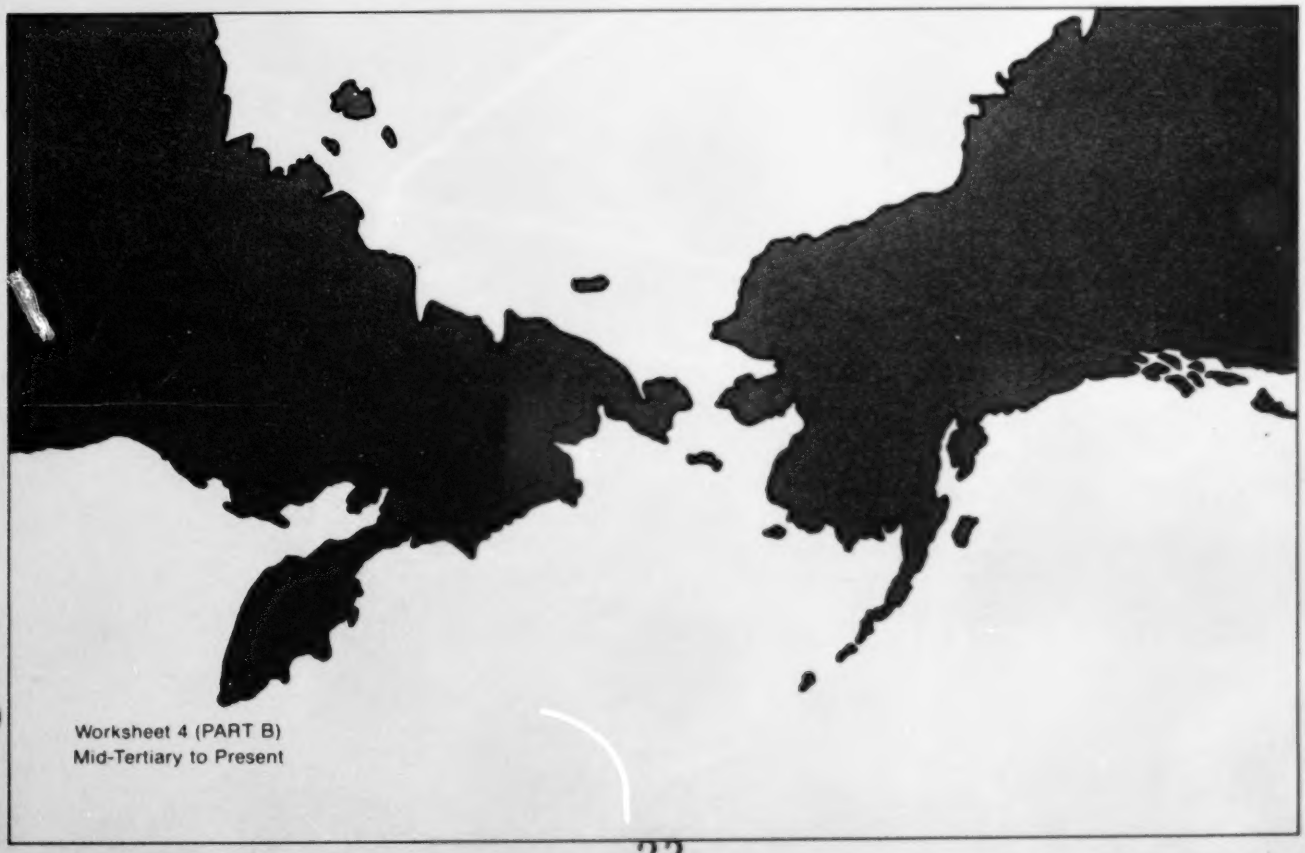


Bridges





Worksheet 3 (PART B)
Early Tertiary



Worksheet 4 (PART B)
Mid-Tertiary to Present